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NONLINEAR AND RANDOM PHENOMENA IN ELECTROMAGNETIC AND
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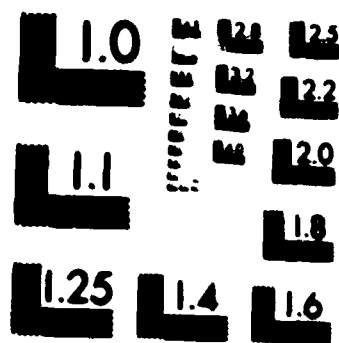
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Electromagnetic Wave Propagation; Acoustic Wave Propagation; Wave Propagation; Acoustoelastic Effect; Random Media; Nonlinearity.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The acoustoelastic effect is the dependence of sound speed upon stress in an elastic solid due to nonlinearity. This effect can be used for nondestructive testing of structural components of aircraft, vehicles, etc. A theory of the effect was developed which involved analyzing acoustic wave propagation in random anisotropic solids. A related theory of the effective elastic constants of solids composed of aggregates of polycrystals was also developed.

For anisotropic composite materials reciprocal relations satisfied by their effective thermal or electrical conductivity tensors were discovered. In the case of scalar materials such relations have been very useful, so the new ones may be useful too. It has also been shown how the elastic properties of the ground could be determined from seismic scattering data. This method used the Born approximation, and led to results involving Fourier transforms.

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**NONLINEAR AND RANDOM PHENOMENA IN ELECTROMAGNETIC
AND ACOUSTIC WAVE PROPAGATION**

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U. S. ARMY RESEARCH OFFICE

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STANFORD UNIVERSITY

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1. INTRODUCTION

Research on nonlinear and random phenomena in wave propagation was conducted during the period covered by this report, January 15, 1985 to January 14, 1987. This research was quite successful, leading to a variety of new results. They are outlined in section 2 and presented in detail in the publications listed in section 3. The personnel participating in the work are listed in section 4

2. MAIN RESULTS

The acoustoelastic effect is the dependence of sound speed upon stress in an elastic solid due to nonlinearity. This effect can be used for nondestructive testing of structural components of aircraft, vehicles, etc. Dr. Bonilla and Professor Keller developed a theory of the effect which involved analyzing acoustic wave propagation in random anisotropic solids. Dr. Bonilla also developed a related theory of the effective elastic constants of solids composed of aggregates of polycrystals.

For anisotropic composite materials, Dr. Nevard and Professor Keller discovered reciprocal relations satisfied by their effective thermal or electrical conductivity tensors. In the case of scalar materials such relations have been very useful, so the new ones may be useful too.

Dr. Boyse and Professor Keller showed how the elastic properties of the ground could be determined from seismic scattering data. Their method used the Born approximation, and led to results involving Fourier transforms.



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3. PUBLICATIONS

A. By J. B. Keller and co-authors

- "Uniform solutions for scattering by a potential barrier and bound states of a potential well," *Am. J. Phys.* **54**, 546-550, 1986.
- "Discriminant, transmission coefficient and stability bands of Hill's equation," *J. Math. Phys.* **25**, 2908-2984, 1984.
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- "Inverse elastic scattering in three dimensions," (with W. Boyse) *J.A.S.A.* **79**, 215-218, 1986.
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- "Irreversibility and nonrecurrence," (with L. Bonilla) *J. Statistical Physics* **42**, 1115-1125, 1986.
- "One hundred years of diffraction theory," *IEEE Trans. Antennas Prop.* **bf AP-33**, 123-126, 1985.
- "Free boundary problems in mechanics," in *Seminar in Nonlinear Partial Differential Equations*, S. S. Chern, editor, Springer -Verlag, New York, 99-115 (1984).
- "Reaction kinetics on a lattice," *J. Chem. Phys.* **84**, 4108-4109, 1986.
- "The Probability of heads," *Am. Math. Monthly* **93**, 191-197, 1986.
- "Soliton generation and nonlinear wave propagation," *Phil. Trans. R. Soc. Lond.* **A315**, 367-377, 1985.
- "Acousto-elastic effect and wave propagation in heterogeneous weakly anisotropic materials," (with Luis L. Bonilla) *J. Mech. Phys. Solids* **33**, 241-261, 1985.

B. By other authors

"Effective elastic constants of polycrystalline aggregates," - L. L. Bonilla, *J. Mech. and Phys. Solids* 33, 227-240, 1985.

"On the stability of inverse scattering problems," - J. Fawcett, *Wave Motion* 6, 489-499, 1984.

"A rigorous derivation of the 'Miracle' of three-dimensional inverse scattering theory," - M. Cheney, *J. Math. Phys.* 25, 2988-2990, 1984.

"Modulational Stability of Ground States of Nonlinear Schrodinger Equations," - Michael Weinstein, (submitted).

4. SCIENTIFIC PERSONNEL SUPPORTED BY THIS PROJECT

Dr. Tomas P. Girnius

Dr. Paul K. Newton

Dr. Isaak Rubinstein

END

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